the machine rears or sinks forward, touches the ground, and loses its required velocity, so that no start is made. Langley experienced great difficulties in this way. Four methods are available.

(1) Starting on a track which the aëroplane cannot leave until the required velocity is reached. (Langley.)

(2) Starting on a track employing a small plane angle, and when a velocity has been reached in excess of the minimum for the machine, raise the planes quickly until the angle suits. The excess of speed will give the initial elevation required. (Farman, Delagrange, Ferber.)

(3) Start from a height, preferably down a slope. (Voisin, Roe.)

(4) Use a frame which can by the store of energy in springs, or a lifted weight, act as a catapult. (Wright Brothers.)

In each case the starting device (carriage, sledge, or catapult) may be integral with, or separate from, the machine. Separately, weight is, of course, saved. On the other hand, the machine is useless without the hoisting device. Starting-stages with necessary catapults or other devices have been suggested. The Aéro Club de France tests machines from a steel tower in the Galerie des Machines, on the principle given third in the foregoing list.

With regard to descent, this is intimately related to gliding stability. As we have seen, if the weight is in the right place, oscillations will be damped out, and the descending machine will follow a straight descending line with a uniform velocity. The alighting springs should be capable of storing the energy of impact corresponding to this speed and angle.

Helicoptères.

It will have become evident from what has been said that this type of machine is more or less at a discount. Machines have been made by Santos Dumont, Kress, Dufaux, and others, but as yet the results are not very important. The ability to soar is undoubtedly a great advantage, but the loss due to insufficient air supply, the absence of wedge action, and the necessity for further machinery to give lateral propulsion are great drawbacks. Mr. Rankine Kennedy is one of the strongest advocates of this type just now, and is evidently convinced as to its ultimate success. The author has interested himself in the type for a long time, but cannot say that at present he considers it to be superior to the aëroplane. In a paper just presented to the Aëronautical Society he has discussed the question.

Ornithoptères.

Profs. Marey and Pettigrew have shown that the wings of flying animals rotate while reciprocating, so as to provide a forward thrust as well as a downward one. (See "The Problem of Flight," p. 59.) The researches of Mouillard, Langley, Fitzgerald, and Deprez have also shown how the greater flying birds manage to utilise the pulsations of the wind and its vertical component to soar and glide. Lord Rayleigh has given simple rules in this connection.

A type not uncommon (on paper) is the rotating machine, in which a number of blades are controlled by a cam, so that on the downstroke they move perpendicular to their planes and on the upstroke parallel to their planes, and thus produce an upward resultant thrust. The mechanical efficiency of such an arrangement cannot be so high as that of an aëroplane. Moy's aërial steamer and centrifugal fan types correspond to this variety.

Future Work.

Reference has been made to the necessity for further research as to the centre of pressure. Information is also wanted as to the resistance and stability of combined planes, the thrust of screw propellers, and the effect of lateral currents on propellers and gliders. The mathematical analysis of the equations of motion of the aëroplane in space needs to be advanced. Simpler forms of the equations of stability and trajectory are required. The application of the latest investigations as to resistance (such as M. Eiffel's) and centre of pressure to these equations has yet to be made, and bird flight needs much study by ornithologists trained in applied mechanics.

Relation to War and Commerce.[1]

The sudden development of aërial navigation led to a popular panic which was quite baseless. At present the dirigible balloon is extremely vulnerable, cannot carry more than a few pounds' weight of projectiles, and has great difficulty in hitting a mark. In espionage it may be useful. Aëroplanes may perhaps be presently available for attacking vital points and despatch work, but it will be long before they will be steady in a wind.

Commercially, the outlook is worse. Although the energy required for aërial transport is not much greater than in terrestrial and marine locomotion, the danger and unpunctuality will take many years to eliminate. Wind occasionally (not frequently) will have serious effects on direction and time of passage. Eventually the airship and flying machine will affect society, but the author thinks it will not be for some years to come.

Finally, the author wishes to point out the deplorable backwardness of English invention in this direction.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following programme for the Darwin centenary celebrations, subject to alteration in detail, will be issued at an early date:—

Tuesday, June 22.—8.30 p.m. to 11 p.m., reception of delegates and other invited guests by the Chancellor in the Fitzwilliam Museum. By kind permission of the master and fellows, the gardens of Peterhouse will be accessible from the museum.

Wednesday, June 23.—10.30 a.m., presentation of addresses by delegates in the Senate house; 2.30 p.m. to 3.45 p.m., visits to colleges; 4 p.m., garden-party given by the master and fellows of Christ's College in the college grounds; 7 p.m., banquet in the new examination hall; 10 p.m. to 12 p.m., the Vice-Chancellor and fellows of Pembroke College "At Home" in the college hall and gardens.

Thursday, June 24.—11 a.m., honorary degrees conferred in the Senate house; 12 a.m., Rede lecture in the Senate house by Sir Archibald Geikie, president of the Royal Society.

A Darwin exhibition will be held in Christ's College on the lines of the Milton exhibition of last year. The syndics of the University Press have agreed to present to each invited guest a copy of the first draft of "The Origin of Species," which is being prepared for press and edited by Mr. Francis Darwin. This is the draft of which Mr. Darwin speaks in his autobiography:—"In June, 1843, I first allowed myself the satisfaction of writing a very brief abstract of my theory in pencil in thirty-five pages."

It is proposed to prepare an illustrated programme of the commemoration containing some account of Darwin's Cambridge days, under the editorship of the registrary, the senior secretary to the celebration committee.

Of the seventeen colleges, fifteen have now published the results of their entrance scholarship examinations. The number of scholarships has slightly increased, and in natural sciences seven and a half more scholarships have been awarded this year than last. The mathematical scholarships are fewer by the same number; the half represents a scholarship which has been awarded partly for natural sciences and partly for some other subject. There is also an increase of four in the history scholarships. Out of the 201 scholarships, 74 have been awarded for classics, 43½ for natural sciences, and 35½ for mathematics. Only eight candidates availed themselves of their privilege of resigning their emoluments whilst retaining the status of a scholar.

The special board for biology and geology has appointed Mr. J. Stanley Gardiner, of Gonville and Caius College, to be a manager of the Balfour fund until June 14, 1911, in succession to Dr. Harmer, who has resigned.

Mr. David Sharp has resigned the curatorship in zoology from March 25, 1909, and Mr. Hugh Scott, of Trinity College, has been appointed in his stead for one year from March 25, 1909.

[1] See article by Prof. Newcomb in the *Nineteenth Century*, September 1908.

The Gordon Wigan income for 1908 at the disposal of the special board for biology and geology has been applied as follows:—(a) 50*l.* to Mr. D. Sharp, the curator in zoology; (b) 50*l.* to Mr. A. G. Tansley, to enable the botanic garden syndicate to continue to offer special facilities for plant-breeding experiments; and (c) 50*l.* to Prof. Hughes, being 30*l.* for the purchase of a projection lantern for the geological department, and 20*l.* for the expenses of research on Pleistocene deposits in the neighbourhood. The prize of 50*l.* from the Gordon Wigan fund for an investigation in chemistry was awarded in the year 1908 to Mr. L. A. Levy, of Clare College, for his essay entitled "Investigations on the Fluorescence of Platinocyanides."

At the last meeting of the committee of Bristol University, the treasurer, Mr. George A. Wills, mentioned that he had received from Lord Winterstoke a letter intimating that he was prepared to give an additional 15,000*l.* towards the University. This, with the 20,000*l.* he had already given, makes Lord Winterstoke's contribution to the fund 35,000*l.*

A very interesting article on foreign associates of national societies, by Prof. E. C. Pickering, of Harvard College Observatory, which was published in the *Popular Science Monthly* in October last, has been received in excerpt form. Prof. Pickering points out that mere membership of scientific societies is, in general, a poor test of the qualifications of a man of science; but the case is very different if only foreign associates of the principal national societies or academies of the world are considered. Dealing with the physical and natural sciences alone, and assuming that foreign associates are elected wholly for eminence in a particular science, Prof. Pickering arrives at some important conclusions so far as the United States are concerned. Speaking of American representation among foreign members of the seven great scientific societies of the world, he says that in the United States the representation per million inhabitants is less than a fifth that of the principal countries of Europe. There is no American representative in mathematics or medicine, while in astronomy there are three out of ten members. Prof. Pickering explains this result by saying that while immense sums are spent on higher education in the United States, the endowment for advanced research is comparatively small. He states that astronomy is almost the only science having institutions in America devoted to research, and in which a great deal of the time and energy of men of science is not expended in teaching. Of the six American foreign associates referred to, five have occupied positions in which no teaching was required, but their entire time was supposed to be devoted to original investigation.

It has often been pointed out that the courses of instruction in schools in India have been hitherto far too literary in character, and that the whole training has not been sufficiently scientific and practical. Education in India has, in fact, suffered, as education in England suffered for a generation, because of the inability of the responsible authorities to understand that book-learning is not the knowledge that makes for progress. The supreme test of educational success is not the power to reproduce the words or works of others, but the ability to undertake an independent inquiry and to arrive at sound conclusions. The science teaching which is truly scientific makes the printed or spoken word subsidiary to the workshop or laboratory exercises, and uses adaptability rather than phonographic capacity as a measure of mental growth. As the only sound basis of scientific instruction is individual experience and activity, the extent of ground which can be studied by practical methods in a school course is necessarily limited. In our schools this is being recognised, and good science syllabuses only include subjects with which pupils may reasonably be expected to become acquainted by experiment. In several provinces of India such a desirable state of responsible opinion does not seem yet to have been reached. For instance, the *United Provinces Government Gazette*, published at Allahabad at the end of last year, contains a science syllabus for the award of high-school scholarships, and we have no hesitation in saying that it would be better not to teach science at all than to attempt to cover the extensive course prescribed for the candidates. In addition to the rudimentary principles of physics and chemistry—which by themselves are more than sufficient for a school course studied by scientific methods—the syllabus includes subjects from sound, light, heat, electricity and magnetism, and chemistry of metals and non-metals. The syllabus in elementary science (physics and chemistry) for the matriculation examination of the University of Madras is of similar character—extensive instead of intensive. To prescribe such syllabuses for Indian students is to put a premium upon learning by reading rather than by doing. It may be urged that practical work is impossible in many Indian schools; but that provides no justification for instituting science courses which require a large equipment of apparatus when taught properly, instead of courses which can be studied experimentally with few special appliances. Directors of public instruction in India who desire to know how the experimental method of science can be successfully introduced into village schools should inquire into the work of the Irish Board of National Education, which has excellent schemes of work capable of being carried out without special equipment and at a minimum cost.

SOCIETIES AND ACADEMIES.

London.

Zoological Society, January 12.—Prof. J. Rose Bradford, F.R.S., vice-president, in the chair.—Observations on the flagellates parasitic in the blood of fresh-water fishes: Prof. E. A. **Minchin.** Five species of Trypanosoma and four species (two new) of Trypanoplasma, from fishes of the Norfolk Broads, were described in detail. Particular attention was paid to the minute structure of the parasites, and it was shown that it is possible to give a uniform description for the nuclear apparatus of both Trypanosoma and Trypanoplasma.—Zoological results of the third Tanganyika expedition, 1904–5. Report on the Copepoda: Prof. G. O. **Sars.**—The gonadial grooves of a medusa, *Aurelia aurita*: T. **Goodey.** The author dealt with investigations which confirmed his earlier suggestion that the gonadial grooves, which lie in the interradial axes between the central gastric cavity and the gastric pouches, have a sexual function. From sectionised material, drawings had been obtained of spermatozoa and eggs lying within the limits of the gonadial grooves, thus proving that the latter are functional gonoducts.—The tuberculin test in monkeys, with notes on the temperature of mammals: Dr. A. E. **Brown.** The paper described the methods and results of experiments which have recently been carried out at the zoological gardens of Philadelphia with the view of suppressing tuberculosis in monkeys.—*Balaena glacialis* and its capture in recent years in the North Atlantic by Norwegian whalers: Prof. R. **Collett.**

Geological Society, January 13.—Prof. W. J. Sollas, F.R.S., president, in the chair.—Labradorite-norite with porphyritic labradorite: Prof. J. H. L. **Vogt.** This rock occurs off the northern coast of Norway. It contains 23 per cent. of labradorite-phenocrysts, in a crystalline groundmass of a more acid plagioclase, hypersthene, diallage, and titanomagnetite. Olivine is conspicuously absent. The plagioclase-phenocrysts are more acid in their outer zones, and the groundmass plagioclase is still more acid. From analyses the relative proportions of the constituents are calculated, and the formula of the felspars determined. The order of crystallisation is found to be:—(1) phenocryst plagioclase; (2) plagioclase with magnetite; and (3) plagioclase, magnetite, pyroxenes. The order of crystallisation follows the physicochemical laws applying to the phase liquid-solid. Graphic representations illustrate the order of crystallisation of a ternary system of plagioclase, magnetite, and pyroxene. Equilibrium between the solid and the liquid albite-anorthite phase must have been maintained long enough for the phenocrysts to acquire a composition different from the first crystals, but eventually the equilibrium broke down. The temperature-interval of crystallisation is estimated to have been between about 1400° and 1000°. This investigation suggests that the processes of crystallisation in a magma may be explained in all details according to physicochemical laws.—The genus